



A Brief Review of Method Available for Dam Break Analysis

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ABSTRACT

Many historical dam failures have led to the inception of a new research field which deals with failure of dams and their resulting consequences. This research field deals with two basic perspectives. The first perspective is to know whether the given dam will fail or not. The second perspective is about assuming the dam failure and analysing the resulting consequences. 'Dam break analysis' basically refers to the process of assuming a breach section and routing the flood wave in the downstream area. The prime objective of such analysis is to facilitate emergency action planning for a possible dam failure. Many flood routing models are available for dam break analysis. Some of the models also provide GIS extensions which facilitate easy preparation of inundation maps

Keywords : Breach geometry, dam break analysis, flood routing, GIS.

INTRODUCTION

Dams are one of the most important structures in the field of water resources engineering. It is an evident historical fact that failure of dams have resulted in high casualties. Many dam failures that occurred during 1960-70 have led to the inception of a new research field that deals with dam failures and its resulting consequences. Following paper gives a brief review of method of dam break analysis. However a brief description of various perspectives of this research field is also presented.

BASIC PERSPECTIVES

There are two basic perspectives to understand this research field that deals with dam failures.

The first perspective is to answer the basic question that whether or not, a given dam will fail. This basically refers to the strength parameter of materials of dam section and this perspective basically deals with simulation of breaching process of dam section. Various parameters relating to dam failure like breach characteristics, time of formation etc. are estimated by this approach.

The second perspective is to assume a given dam failure and study the resulting consequences in the downstream area. This approach helps in preparation of emergency action planning for a possible failure of dam. The final basic product of such analysis is inundation details of downstream area owing to the flood generated due to the failure of dam.

BREACH MODELING

The term 'Breach modeling' basically refers to the process of understanding and simulating the breach development in a dam. Breach modeling generally relates to the first perspective of this research field as stated earlier. Two breach forming mechanisms are identified: erosion and headcut-erosion. The Erosion process is modelled using the sediment transport equations that are conventionally derived for steady subcritical flow conditions, specific types and certain diameter ranges of sediment. However, the term headcut-erosion represents a process of removal of structural material by combined effect of the erosive force of water flow and by mass washing. Laboratory experiments and observations of real earthfill structure failures show that erosion is predominant for non-cohesive struc-

tures without a cohesive core. Headcut erosion is observed to be predominant during the breaching of structures with cohesive filling material, or with non-cohesive filling material but with a cohesive core. Various computer models are developed which simulate the breaching process. Such models include BREACH, BREADA, BEED, BRDAM, NRCS SITES model etc.

DAM BREAK ANALYSIS

The term dam break analysis usually relates to the process of studying a dam failure phenomenon and analysing the resulting consequences at the downstream region. This generally deals with simulation of assumed failure for existing dams and analysing the resulting consequences. The prime objective of such a study is to facilitate effective emergency action planning for possible dam failures.

Following points give a general methodology for dam break analysis:

1. The first step for dam break analysis is the assumption of dam failure. This includes assuming breach geometry based on the guidelines provided by various research agencies. Such guidelines are the result of extensive case studies of historical dam failures as well as laboratory experiments. The breach geometry depends on type of dam as well as the material of dam. For the sake of dam break analysis, most of the researchers have suggested the assumption of trapezoidal shape for the breach geometry. Following table gives some of the guidelines for assuming breach geometry for dam break analysis.

Table 1 Breach parameters for earthfill and concrete dams

Dam type	Average breach width (expressed as Dam Height)	Side Slope of Breach Zb (Zb Horizontal : 1 Vertical)	Failure Time (Hours)
Earthfill Dam	Min: 0.4 Max: 13 Mean: 4	Min: 0 Max: 6 Mean: 1	Min: 0.1 Max: 12 Mean: 2
Concrete Gravity Dam	Integer Multiple of Monolith width	Vertical	0.1 to 0.5
Concrete arch dam	Entire valley width	Valley wall	0 to 0.1

The following figure gives a brief idea about the breach geometry assumption:

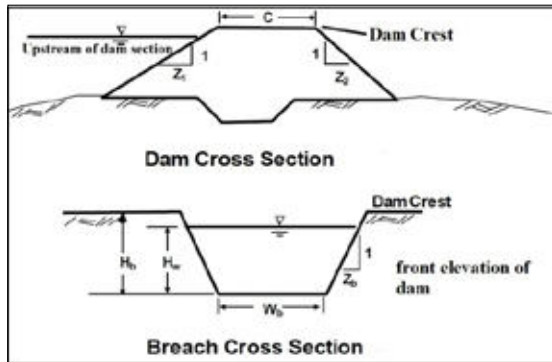


FIGURE 1 Breach geometry assumption for dam break analysis

2. The second step is to route the flood wave in the downstream region, generated due to the breaching of dam section.
3. The third step includes the analysis of flood routing results which gives an idea about the inundation of downstream region and the effect of flood at various points.

FLOOD ROUTING MODELS

Various computer models are available which can be used for routing of flood wave generated by assumed dam failure. Such models can be broadly classified into two categories: one dimensional routing model and two dimensional routing models.

One-dimensional routing models:

These models treat the flow through the channel and the flood plains only in longitudinal direction. Hence the equations are solved from one cross section to another in one dimension. These equations for modeling the one-dimensional flow are derived from the conservation of mass and conservation of

momentum equations between adjacent cross-sections. Some of the one dimensional routing models include HEC-RAS (Hydrologic Engineering Center- River Analysis System), Full Equations (FEQ) model, FLDWAV (developed by national weather services), ISIS Flow (Developed by Wallingford Software) etc.

Two-dimensional models:

Two dimensional hydraulic models are based on integration over the flow depth to obtain depth averaged velocity values and are solved using an appropriate numerical approach such as a finite element model. The routing is done in longitudinal as well as lateral directions. Some of the two dimensional models are MIKE FLOOD (Developed by DHI Group, Denmark), BASEMENT, CCHED-FLOOD etc. FLO-2D: two dimensional flood routing, FESWMS model etc.

GIS APPLICATIONS

Various softwares of Geographic Information System can be incorporated in dam break analysis. Many flood routing models provide GIS extensions which facilitate further analysis of their results on GIS platform. An example of such extension is HEC-GeoRAS, which is an extension of HEC-RAS for GIS application. HEC-GeoRAS is an effective tool specifically designed to be used in ArcGIS software to facilitate import/export of data and results between HEC-RAS and ArcGIS. Such extensions are highly useful in dam break analysis as they provide an easy way to prepare inundation maps.

CONCLUSION

Failure of dams may result in great loss to life and property. Hence dam break analysis must be considered as a mandatory requirement as a part of disaster management programme. Guideline proposed by various research agencies for the sake of dam break analysis may be used for this purpose. Many computer models are developed which can be effectively incorporated for dam break analysis. The inundation maps prepared as a final product of dam break analysis are extremely useful for emergency action plans. Still there is lot of scope for further research in this field and must be encouraged by the government.

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